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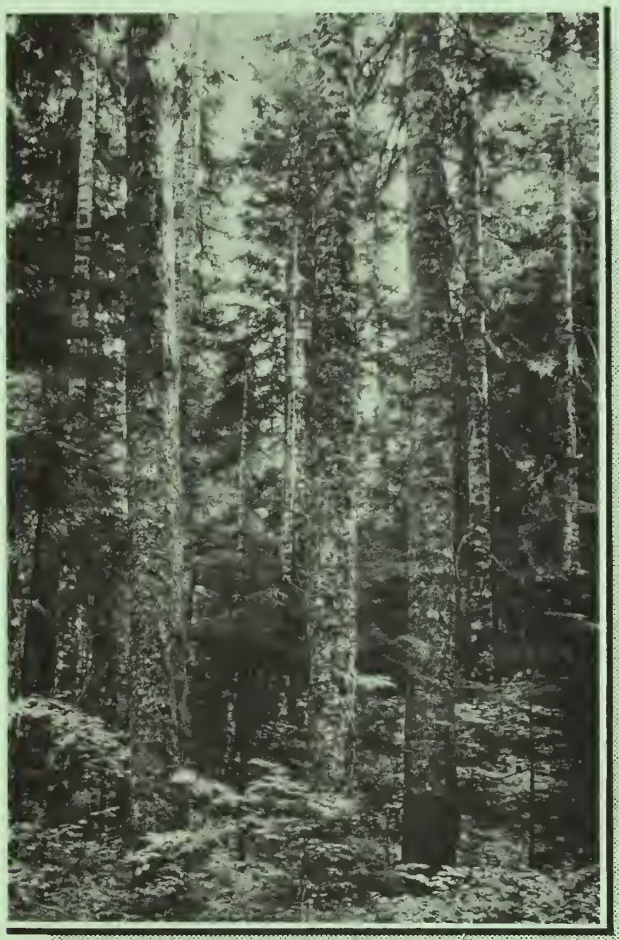
SILVICAL CHARACTERISTICS of PACIFIC SILVER FIR

by EDWARD J. DIMOCK, II



SILVICAL SERIES NO. 4

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
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SILVICAL CHARACTERISTICS OF PACIFIC SILVER FIR

by

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Rising as a green and silver-gray spire beneath the summer sun, or shimmering white under a mantle of new-fallen snow, the Pacific silver fir (Abies amabilis)[1/] ranks among the most beautiful forest trees in the Pacific Northwest. One of its common names, lovely fir, forms the literal basis for the Latin derivation and is truly descriptive of the species. Other names in common usage are: Cascades fir, amabilis fir, red fir, silver fir (lumber), and white fir (lumber) (15).[2/]

Formerly an object of the lumberman's scorn, Pacific silver fir now commands due respect as a commercially valuable species. Highly adaptable to the manufacture of paper pulp, the species vies with western hemlock and Douglas-fir as a leading source of pulpwood in the Pacific Northwest. Principal uses of the lumber are for framing and sheathing in house construction, and for box shook. The species is planted as an ornamental shade tree in parts of eastern United States and western Europe.

Pacific silver fir ranges (fig. 1) from the southeastern extremity of Alaska (55° N. latitude) south along the coast of British Columbia through western Washington to southern Oregon (43° N. latitude). Optimum development is attained on the lower west and south slopes of the Olympic Mountains, the west slopes of the Washington Cascades, and the foothills of the lower Columbia River region in Washington and Oregon (8). Peak growing conditions also exist on the west coast of Vancouver Island. The commercially available sawtimber volume of the species is about 75 billion board-feet, of which approximately 95 percent is located in British Columbia and Washington.

[1/] Scientific and common names of trees in this publication follow: Check list of native and naturalized trees of the United States (including Alaska) (15).

[2/] Underscored numbers in parentheses refer to Literature Cited.

Figure 1.--Range of Pacific silver fir.

HABITAT CONDITIONS

Climatic

Precipitation is high throughout the range of Pacific silver fir, averaging 40 to 140 inches annually; at upper elevations this may include considerable snowfall. As classified by Thornthwaite (24), the species range falls entirely within the humid and superhumid zones, which are characterized by moderate temperatures with little daily and seasonal variation, and by long growing seasons with contrastingly short, late-summer dry periods (23).

Edaphic

Pacific silver fir occurs principally on lower slopes of canyons, benches, and flats, though it may grow prolifically on upper slopes and ridgetops as well. Though the species shows some preference for north slopes, greatest abundance normally occurs on southern and western aspects in the central and south-central parts of its range (23). Whatever the aspect, the tree requires a well-drained soil with an abundant moisture supply. It grows best on deep, medium-textured soils, but may be found on soils varying over a wide range of texture and depth.

Physiographic

In the northernmost part of its range (southeastern Alaska and northwestern British Columbia) Pacific silver fir grows from sea level to approximately 1,000 feet. Farther south in the Olympics and Cascades of Washington and Oregon, it occurs from slightly below 1,000 feet to 5,000 feet, and in some instances up to slightly more than 6,000 feet. As with other species, its altitudinal limit tends to increase with southward latitudinal distribution.

Biotic

Pacific silver fir is a major component of both the Canadian and Hudsonian Life Zones (16, 17). It is of present commercial importance, however, in only the former. In the latter it is a characteristic associate of mountain hemlock (*Tsuga mertensiana*), Alaska-cedar (*Chamaecyparis nootkatensis*), subalpine fir (*Abies lasiocarpa*), and whitebark pine (*Pinus albicaulis*) (13). In general, its common tree associates are western hemlock (*Tsuga heterophylla*), Douglas-fir

(Pseudotsuga menziesii), white fir (Abies concolor)[3/] and Sitka spruce (Picea sitchensis)(6); western redcedar (Thuja plicata) and grand fir (Abies grandis) (10); and Engelmann spruce (Picea engelmannii) and noble fir (Abies procera) (19). At higher elevations it is also found with western larch (Larix occidentalis) and western white pine (Pinus monticola) (6); lodgepole pine (Pinus contorta) and California red fir (Abies magnifica)[3/] (8).

The Society of American Foresters (21) lists Pacific silver fir as occurring in seven North Pacific forest cover types:

Type No.	Name
223	Sitka spruce (subclimax type)
224	Western hemlock (climax type)
225	Sitka spruce--western hemlock (climax type)
226	Pacific silver fir--hemlock (climax type)
227	Western redcedar--western hemlock (climax type)
229	Pacific Douglas-fir (subclimax type)
230	Douglas-fir--western hemlock (midphase type)

The species is a common associate in types 223, 224, and 226; a light or occasional component in types 229 and 230; and occurs in transition forms or variants of types 225 and 227.

Among the chief shrub associates are the following, as listed by Jones (13) for the Olympic peninsula:

Canadian zone: ovalleaf whortleberry (Vaccinium ovalifolium),[4/] big whortleberry (Vaccinium membranaceum), Oregon wintergreen (Gaultheria ovatifolia), snow dewberry (Rubus nivalis), rusty menziesia (Menziesia ferruginea), Arizona mountainash (Sorbus dumosa), vine maple (Acer circinatum), and Sitka alder (Alnus sinuata).

Hudsonian zone: common juniper (Juniperus communis), Sitka alder, mapleleaf currant (Ribes acerifolium), western

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[3/] In the author's opinion, Abies concolor and A. magnifica are associates of Pacific silver fir only in the southern extremity of its range.

[4/] Scientific and common names of shrubs and herbs in this publication follow: Kelsey, Harlan P., and Dayton, William A. Standardized plant names. Ed. 2, 675 pp. Harrisburg, Pa. 1942.

mountainash (Sorbus occidentalis), myrtle pachistima (Pachistima myrsinites), bearberry (Arctostaphylos uva-ursi), rusty menziesia, Utah honeysuckle (Lonicera utahensis), and bush cinquefoil (Potentilla fruticosa).

LIFE HISTORY

Seeding Habits

Flowering and Fruiting.--As in all species of Abies, the flowers of Pacific silver fir are unisexual and borne during the spring in small, cone-like clusters on branchlets of the previous season's growth. The pendant male strobili are borne in the upper half of the crown; the female strobili stand erect on branchlets in the uppermost part of the crown. The fruit, which ripen in the fall of the same year, are erect cones with closely imbricated scales. The scales of the mature cone fall away with their large-winged seeds and leave behind the spike-like axis of the cone, which often persists on the tree for several years (25).

Prior to seed dispersal, cones and their immature seeds may be damaged or destroyed by a number of agents. Two species of seed chalcids (Megastigmus lasiocarpae and M. pinus) are injurious to Pacific silver fir seed within immature cones (14, 25). It is probable that small mammals, such as the Douglas squirrel (Tamiasciurus douglasii douglasii), cut and destroy a significant number of immature cones. Subfreezing weather during the spring flowering period may occasionally have an adverse effect on seed production in years of climatic extremes.

Phenological data[5/] for flowering and growth habits are listed below:

	Dates
Flowering buds burst	April 19 to May 5
Flowering ends	May 2 to May 17
Vegetative buds burst	May 4 to May 22

5/ Average range of dates within which given phenological development occurred in given species at points in Oregon and Washington. Dec. 9, 1952. (Unpublished data. On file U. S. Forest Serv., Pac. NW. Forest and Range Expt. Sta.)

Seed Production and Dissemination. --Very little is known concerning the initial, optimum, and maximum ages at which Pacific silver fir produces seed. It probably begins to produce seed at about age 20,[6/] and the intervals between good crops thereafter average about 2 or 3 years (25). Viability of seed on the basis of nursery tests varies from 1 to 55 percent, and averages about 22 percent. Individual seeds are relatively large and average 11,300 (8,200 to 14,900) to the pound. Seedfall begins from August 23 to September 19[7/] and ends in late October (25). Squirrels and other small mammals evidently consume a high proportion of the seed as soon as it begins to fall.

Small mammals and birds probably play a very minor role in seed dispersal; most dissemination occurs by wind. Since the seeds are moderately large, they are seldom carried any great distance from the parent tree. Siggins (20) has determined that Pacific silver fir seed falls at about 4.95 feet per second in still air.

Vegetative Reproduction

In nature, regeneration of Pacific silver fir is entirely by seed (8). Little, if any, work has been done on propagation of the species by cuttings or by grafting.

Seedling Development

Establishment. --Under normal conditions, seeds of Pacific silver fir germinate in the spring following a winter layover period on the ground. Moist duff, moss-covered humus, and mineral soil form equally favorable media for seedling establishment (23, 25).

Combined with the relatively low and transient viability of the seed, moisture is apparently quite critical at this stage. During initial stages of establishment, seedlings are probably more susceptible to adverse effects of climate and competing vegetation than to disease, insects, and small mammals. Stein (22) notes that germination of Pacific silver fir and noble fir seed on snow may seriously reduce the percentage of successful seedling establishment.

6/ Estimated by Forest Service personnel.
7/ See footnote 5, page 5.

Early Growth.--Moderate to heavy shade is most favorable for early survival, although Hanzlik (8) found that Pacific silver fir seedlings would thrive in the open if sufficient moisture in both soil and atmosphere was present. Though the species can reproduce under heavy shade, growth of seedlings under such conditions is extremely slow. Most rapid development, on the other hand, is attained in the open where the seedling has greater freedom from root and crown competition. This might well indicate that Pacific silver fir is adaptable to even-aged management based on a clear-cutting method of seedling establishment.

Sapling Stage to Maturity

Growth and Yield.--Pacific silver fir seldom occurs in pure stands; consequently, little information exists in regard to growth and yield of the species. In some overmature climax types, where it occurs in approximately equal proportion with western hemlock, total volumes per acre for both species may run over 70,000 board-feet per acre on good sites.

Individual trees attain maximum heights of about 200 feet, with diameters occasionally over 6 feet. The largest specimen currently on record (1) measures 6 feet 10 inches in diameter breast high with a total height of 186 feet and crown spread of 38 feet. The species is a moderately slow grower and frequently reaches a diameter of only 2 feet at 200 years (6). Average age at time of death is probably 300 years,[8/] though occasional trees may far exceed this longevity limit.

Reaction to Competition.--Baker's revised tolerance classification (2) lists Pacific silver fir as a tolerant species. For lack of better information, it might also be inferred that the tree is not a rapid natural pruner, a factor of possible significance in young-growth management. Its response to release, however, is noted with enthusiasm by Hanzlik (9): "...silver fir is one of the most remarkable trees to respond in both height and diameter growth when opened up to light and freed of root competition. Trees growing suppressed for from 70 to 100 years and only from 2 to 3 inches in diameter and 10 to 15 feet tall, show an exceedingly good pickup, and after a few years have the appearance of young trees above the height they had at the time of liberation."

[8/] Estimated by Forest Service personnel.

As previously mentioned, Pacific silver fir is found in a number of tree associations, but primarily in those of the climax type. It reaches its peak development in the Olympic Mountains of Washington, where it is the commonest true fir, occurring mostly in the Pacific silver fir--hemlock type or in occasional pure stands. From observations made on the Humptulips and Satsop River drainages, Hanzlik (9) feels that Pacific silver fir rather than western hemlock is the true climax for most of the region west of the Cascades and in the Olympics. In cases where severe ecological upsets by fire or windthrow have not taken place for 500 years or more, the final successional stage appears to be a mostly uneven-aged stand of Pacific silver fir--until a catastrophic fire or windstorm effects a retrogression to some characteristic subclimax type.

Damaging Agents.--Until quite recently, Pacific silver fir was thought to have few insect enemies, and none of appreciable importance. Insects that were known to kill individual trees were identified by Keen (14) as the flatheaded fir borer (Melanophila drummondi) and the silver fir beetle (Pseudohylesinus grandis).

An extensive outbreak of bark beetles attacking and killing Pacific silver fir was reported in 1950 by Hogan (11). The outbreak, which spread over western Washington and northwestern Oregon, began in 1947 and reached a peak in 1954 (26). During this epidemic it became evident that the fir root bark beetle (Pseudohylesinus granulatus) equalled or exceeded in destructiveness its first cousin (P. grandis).

In 1954 another insect, the balsam woolly aphid (Chermes piceae) was discovered killing Pacific silver fir in southwestern Washington and subalpine fir in the Cascade Range of Oregon. Since then the epidemic has spread until it covers 600,000 acres in these two States, necessitating extensive salvage logging to utilize the dead and dying timber. Introduced from Europe to Nova Scotia about 1900, the woolly aphid spread to the Pacific Coast where it now is the most destructive insect attacking Pacific silver fir. Efforts are being made to effect natural control by importing predators (12, 18).

At younger ages, Pacific silver fir is relatively free from disease. However, as they approach maturity, individual trees are subject to a number of epidemic diseases, which may dictate relatively early pathological rotations in some areas (3). Three heart rots (Echinodontium tinctorium, Stereum sanguinolentum, and Fomes pini) are considered among the most serious wood destroyers (3, 7).

Recent work has shown that Armillaria mellea is an important root rot, working in conjunction with bark beetle attacks (27). Several other butt and trunk rots (Poria subacida, Fomes annosus, Polyporus sulphureus, Fomes pinicola, Stereum abietinum, and Hydnum sp.) are also common in Pacific silver fir (5). There is some evidence from studies in British Columbia that Pacific silver fir up to 350 years old is more resistant to disease attack than its close associate, western hemlock.

Windthrow, fire, and climatic extremes also take their toll of Pacific silver fir in the sapling to maturity stages. Because of its relatively shallow rooting system and thin bark, it presents little resistance to severe windstorms or fire. It apparently has a moderately low susceptibility to frost damage in the sapling stages, though it is not quite as resistant in this respect as noble fir (4).

RACIAL VARIATIONS

No racial strains of Pacific silver fir have been recognized. However, there is some evidence that climatic races do exist, though present knowledge concerning them is incomplete.

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